Village Creek Water Reclamation Facility

Fort Worth Water Department

Introduction

Village Creek Water Reclamation Facility (Village Creek WRF) serves more than 880,000 people and numerous industries in 22 communities. This City of Fort Worth owned and operated plant is permitted and capable of processing 166 million gallons of wastewater each day.

The service area consists of most of Tarrant County and portions of Denton and Johnson counties. As part of the Dallas/Fort Worth Metroplex, it is one of the largest and fastest growing areas in the United States that does not have a major waterway for disposal of treated wastewater.

Village Creek WRF and surrounding areas discharge treated effluent into the sensitive Trinity River. During dry months, the river may be composed of up to 95% treated wastewater, making the Village Creek WRF performance critical to the Trinity's vitality and usefulness as a drinking water source for those downstream.

The biosolids produced from the treatment process (110 dry tons per day) are processed and stabilized resulting in Class AB biosolids. The City's goal is to beneficially reuse/recycle all of the biosolids produced at Village Creek WRF by land application on area farm and ranch lands in Tarrant and six surrounding counties.

In 1988, the EPA recognized Village Creek WRF as the best large advanced Water Reclamation Facility in the country by awarding it the National EPA Operations and Maintenance Award of Excellence. In addition, in 1998 and 1999 Village Creek WRF

earned the EPA National “Honorable Mention” award for an “Outstanding Project involved and enhancing Beneficial Use of Municipal Wastewater Biosolids for a Large Operation Project.”

Wastewater Treatment Process

Village Creek WRF uses the same purification methods found in nature: settling, filtration and biological activity. Plant design and operation allow the purification and stabilization processes to take place in a much smaller space, within a shorter time frame and at a low cost. The “Village Creek WRF Facility Description” table presented later in this section illustrates some of the methods utilized at the plant.

The City of Fort Worth wastewater collection system consists of approximately 3,300 miles of sanitary sewer. The majority of the system is gravity flow; however, the City maintains over 50 pump stations to service the lower lying areas within the basin. The wastewater enters the Village Creek WRF through two 96-inch sewer collector mains and one 54-inch sewer collector main. As the wastewater enters the plant, chlorine is added to provide seasonal odor control. The flow volume is also measured using Parshall flumes.

Headworks—Bar Screens and Fine Screens

Headworks Facility

The wastewater flow entering the plant goes through the Headworks Facility. The flow passes through “roughing” bar screens—a row of closely and evenly spaced bars across the influent channel (3/4 inch openings). The “roughing” bar screens remove large objects that could block pipes or damage equipment. The bars are cleaned periodically with an automated mechanical rake and the material removed from the bars is taken to a sanitary landfill.

A new Headworks Facility was constructed in 2005 to remove more materials at the beginning of the treatment process. This new facility has reduced rag buildup in other treatment areas at the plant. The new facility is equipped with 6mm fine screens. The 6mm fine screens capture and remove suspended solids, rags, plastics, etc. from the wastewater flow and the screens are mechanically cleaned. The material captured by the fine screens is compacted and taken to a sanitary landfill. Fine screens have also

been installed in one bay of the existing Bar Screen Building #3. The remaining bays in Bar Screen Building #3 have 1 inch bars and are maintained for emergency use.

High Rate Clarifier

High Rate Clarifier

The High Rate Clarifier (HRC) is designed and permitted to treat high flow situations. Whenever instantaneous flows to the Headworks Facility equal or exceed 255 MGD, wastewater flow will be directed from primary treatment to the HRC, processed and discharged directly to the facility's disinfection units. This allows detention times in the primary and secondary treatment stages to remain constant while the excess wastewater is treated in the HRC. The HRC can treat 80 MGD.

The sludge generated by the HRC will flow to the gravity belt thickeners to remove excess water. The liquid is sent to secondary treatment and the concentrated sludge is fed into the sludge blend tank.

Primary Treatment

Primary Clarifiers

After passing through bar screens, the wastewater flow goes to the primary clarifiers. In these large circular tanks, the wastewater flow is slowed to about one foot per minute so

heavier solid materials can settle to the bottom. Grease and oil (scum) float to the surface and are hauled off for landfill disposal.

The solids that settle out (sludge) are pushed to the center of the clarifier (sedimentation tank) and pumped to the sludge degritting facility for removal of sand and gravel. The majority of the wastewater that flows through the clarifier overflows the weirs and is then pumped to secondary treatment.

Secondary Treatment

Aeration Basins and Final Clarifiers

Village Creek WRF uses conventional activated sludge as the heart of its treatment process. The biological treatment mimics the processes used by nature for purifying lakes and streams.

This process biologically converts pollutants that will not settle into substances that will settle. The wastewater is mixed with bacteria-rich activated sludge in large aeration basins. Compressed air is fed through fine bubble diffusers to provide the bacteria and other microorganisms with enough oxygen to support the biological process in the wastewater. The bacteria consume organic matter in the wastewater; it is important that this process is controlled to minimize the biological “burning up” of organic material.

Dissolved and suspended impurities in the wastewater are incorporated into the activated sludge floc through adsorption (when solids stick to the surface of the bacteria) and absorption (when dissolved gases and solids are taken into the bacteria where they can be assimilated) by the microorganisms.

The mixture of treated wastewater and activated sludge from the aeration basins is then transferred to final clarifiers where gravity separates the microorganisms from the wastewater. The clarified wastewater again overflows the clarifier weirs and moves on to the effluent filtration phase of treatment.

The majority of the settled activated sludge is returned to the aeration basins to continue the treatment process. A small portion of the sludge is pumped to the Waste Sludge Concentration. Scum floating on the surface of the final clarifiers is removed and hauled off for landfill disposal.

Effluent Filtration

Traveling and Deep Sand Bed Filters

The remaining solids suspended in the wastewater are removed by the passing of the wastewater through multimedia filters composed of gravel, sand and anthracite coal. Filters are cleaned periodically by “backwashing,” or sending clean water backward through the filter which flushes out impurities. During backwashing the filter bed expands and media particles bump against each other, allowing impurities to be washed away. Newer filters use only sand and a traveling bridge that continuously backwashes the filter, one small cell at a time.

Backwash water is moved to an equalization basin and fed at a constant rate to the backwash clarifier, where the solids settle out. Solids are transferred to the Waste Sludge Concentration and clarified backwash water is filtered again.

Chlorination / Dechlorination

Chlorine Contact Basin

After effluent filtration, the wastewater enters the chlorine contact basins, where it is mixed with chlorine and held for 20 minutes for disinfection. The chlorine kills most of the disease-causing viruses and bacteria that remain in the effluent.

However, since chlorine and its by-products are toxic to aquatic life, sulfur dioxide is added after chlorination to remove the chlorine residuals. Sulfur dioxide dissolves in water to form sulfite, which reacts immediately with chlorine to form harmless chloride

ions. After chlorination and dechlorination, the wastewater looks much like drinking water and is discharged to the Trinity River.

Primary Sludge Degritting/Concentration

The sludge that settles to the bottom of the primary clarifiers is pumped to the Grit Removal Facility. The heavy inorganic particles, such as fine sand and small gravel (grit), are removed using cyclone degritters. The grit is classified (washed) and moved by conveyors to the grit slurry tank where water is added to the grit and the grit slurry is pumped to the digested sludge well. The grit/digested sludge is pumped to the Dewatering Facility for further processing and proper disposal. In June 2014, a project was started to evaluate the feasibility of a grit removal system. The purpose of the grit removal system would be to divert all grit to the landfill for final disposal instead of it being sent to the digesters.

After degritting, sludge flows to gravity thickeners to remove excess water. The liquid in the thickener overflows a weir and is returned to secondary treatment and the thickened primary sludge (approximately 4-5% solids) is fed to the Sludge Blend Tank. At this stage the primary sludge is mixed and blended with secondary sludge and is fed to the anaerobic digesters.

Waste Sludge Concentration

Village Creek WRF uses dissolved air flotation thickeners (DAFT) to concentrate the waste activated sludge from the final clarifiers. Compressed air is pumped into a mixture of water and waste sludge. Small bubbles of air form on the sludge particles making them less dense than water which causes the sludge to float on the surface of the DAFT. The concentrated floating sludge is removed by a skimmer and pumped to the Sludge Blend Tank. The remaining liquid (subnate) is pumped to the secondary treatment area for further processing.

Anaerobic Digestion / Stabilization

Anaerobic Digesters and DAFTs

Co-Digestion Building

The blended sludge is fed to the anaerobic digesters from the blend tank. The digesters provide an environment where anaerobic bacteria (bacteria that cannot live with oxygen

present) are able to thrive and can break down the organics in sludge into stable compounds.

Anaerobic digestion reduces solids, odors and pathogens; and it conditions sludge which makes dewatering more rapid. Methane gas, produced as a by-product of this process, is used for mixing the digesters. This biogas is also used onsite as fuel to power (5.2MW) gas turbine engines which generate electricity. The exhaust heat from these turbines is run through a heat recovery system to create steam which is used to power two (30,000 CFM) steam turbines. The air produced by the steam turbines is used to supply oxygen to the aeration basins and reduces the electricity needed to power electric blowers that would otherwise be required.

In September 2012 Village Creek WRF completed construction of a high strength waste unloading station and started accepting high strength wastes (i.e. food processing wastes). The codigestion of wastewater solids and high strength wastes has increased the onsite production of biogas which has reduced the amount of fuel that needs to be purchased for the gas turbine engines.

Odor Control

Covered Thickeners, Biofilters and Air Scrubbers

Village Creek WRF is located near a growing residential area, and controlling odors generated by the plant is a high priority. Many of the treatment processes, such as bar screening and cyclone degritting, are enclosed in air-scrubbed buildings. The primary sludge thickeners, waste sludge DAFTs and the weirs of the primary clarifiers are also covered and scrubbed. Village Creek uses both wet scrubbers and carbon adsorption scrubbers. Other odor control measures include the addition of chlorine to incoming wastewater, use of biofilters, optimization of treatment processes and maintenance of good housekeeping around the plant.

Village Creek WRF Facility Designs

Plant Loadings	
Rated capacity, MGD	166
Average daily flow (2011-2012), MGD	112
Discharge Standards	
CBOD, mg/L	7
Total Suspended Solids, mg/L	15
Discharge Performance (2011-2012)	
Average BOD, mg/L	2.1
Average Total Suspended Solids, mg/L	2.1
Pretreatment	
Bar Screen Unit	
Primary Treatment	
80-foot diameter clarifier	12
160-foot diameter clarifier	6
Secondary Treatment	
Conventional activated sludge with fine bubble diffused air	
Aeration Basins	
3.41 million gallons	6
3.37 million gallons	6
1.54 million gallons	4
Final Clarifiers	
150-foot diameter	9
130-foot diameter	4
110-foot square	2
95-foot diameter	6

Filtration	
Dual-media gravity filter	20
Continuous backwash filter	12
Disinfection	
Chlorination contact time, minutes	20
Dechlorination, MGD	166
Sludge Processing	
65-foot diameter primary sludge thickener	4
Gravity Belt Thickeners	2
DAFT unit	4
80-foot diameter anaerobic digester	2
90-foot diameter anaerobic digester	12
Sludge drying beds (standby)	225 acres
Contract Dewatering	
Belt-Filter Press (2 meter)	5
Liquid Sludge Holding Tank	2
Lime Storage Silo & Pug Mill	1
Truck	7
Centrifugal Blowers	
60,000cfm electric blower	1
25,000cfm electric blower	5
30,000cfm steam blower	2
Generators	
1250KVA	2
Electricity	
5.2MW Gas Turbines	2
Heat Recovery Steam Generator	1

Biosolids Beneficial Reuse

History

The Fort Worth Water Department has always been dynamic and progressive in the area of beneficial reuse of sludge (biosolids). The Village Creek WRF staff is committed to meeting its goal of beneficially resusing all biosolids produced via land application.

Air-dried biosolids have been beneficially reused since the opening of the first Water Reclamation Facility in Fort Worth in 1923 (Riverside, closed in 1980) and continued until the early 1990s with Village Creek WRF (1953-present). These air-dried biosolids from the drying beds were beneficially reused until the late 1980s on area highway easements and medians as a soil amendment and fertilizer though agreements with the Texas Department of Transportation. Parks, golf courses and the plant nursery operated by the City also used biosolids fertilization to sustain and enhance grass and tree growth.

Due to population growth, plant expansion and implementation of new regulatory requirements in the late 1980s, the Water Department began looking at other processes of sludge dewatering and beneficial reuse. Since the North Texas area is surrounded by farm and ranch lands, mechanical dewatering by belt-filter press and beneficial reuse/recycling of biosolids by land application was found to be the most cost effective.

Biosolids Dewatering (Belt-Filter Press)

Belt-Filter Press

Thorough a contractual agreement in 1991, Village Creek WRF privatized 40% of the sludge dewatering (by belt press), transportation and beneficial reuse of biosolids by land application. Due to the success and public acceptance of the program, subsequent contracts were issued with increasing amounts of biosolids processing. The Dewatering Facility is located one mile north of Village Creek WRF at the Sludge Only Landfill (SOL) site. A private contractor operates and maintains belt-filter presses used to mechanically dewater (press and squeeze moisture out of) the biosolids at the Dewatering Facility. Polymer is added to the biosolids as a conditioner and to aid the dewatering process. The processed and dewatered biosolids (21-27% solids) are

conveyed to a pug mill where lime is added to achieve a pH of 12.0 after two hours and a pH of 11.5 after an additional 22 hours, to further stabilize the biosolids.

Class AB Biosolids

Lime Storage Silo & Pug Mill

On September 10th, 2014 the Texas Commission on Environmental Quality (TCEQ) amended the existing biosolids regulations as defined in 30 TAC Chapter 312. The revised regulations included a new designation for biosolids (Class AB) as well as requirements for odor control plans and the posting of signage at land applications sites. The new provisions became effective on October 2, 2014 at which time the Fort Worth land application activities assumed the new "Class AB" classification. Class AB biosolids results from the combination of excellent pretreatment, full anaerobic digestion (21-25 days at 97˚F) and post-lime stabilization. The Class AB biosolids are beneficially reused/recycled as a fertilizer and soil conditioner.

Beneficial Recycling by Land Application

The biosolids produced at Village Creek WRF amount to approximately 90 dry tons per day are beneficially reused/recycled as a fertilizer and soil amendment by land application in Tarrant and six surrounding counties. A private contractor transports and land applies the Class AB biosolids at agronomic rates on cropland and pastureland.

More than 40 landowners, accounting for over 75 sites and more than 40,000 noticed acres participate in the Fort Worth Biosolids Program. There is a 60-day waiting list for biosolids application.

Public / Private Partnership

Since 1991, Village Creek WRF has partnered with Renda Environmental Inc., a private contractor, to provide beneficial reuse/recycling of biosolids produced. This positive and long-term public/private partnership facilitates joint problem solving, cohesive communication and dedication to safe recycling of biosolids.

Benefits of Biosolids Fertilization

Agricultural users of Fort Worth Biosolids have observed and documented:

- Increased hay and crop production
- Enhanced crop and forage quality
- Improved and enhanced soil conditions
- Increased soil organic matter aggregation, plant rooting and soil tilth
- Increased cow/calf grazing pressure
- Higher total digestible nitrogen content
- Decreased soil erosion
- Increased nutrient availability throughout crop growing season

Sludge Drying Beds

Approximately one mile northeast of the Village Creek WRF, lies 240 acres of sludge drying beds. From 1970-1995, the drying beds were the final step (dewatering by natural air-drying) in biosolids processing. The biosolids were removed from the beds each summer and beneficially reused/recycled as a fertilizer and soil conditioner on area parks, golf courses, highway easements and farmlands.

In April 1995, Village Creek ceased pumping sludge to the drying beds. The biosolids that remained in the drying beds and adjacent stockpiles were removed and beneficially reused as a fertilizer and soil amendment under a series of contracts from 1996-2001.

The final biosolids were removed form the drying beds in October 2001, thereby completing the removal contracts.

The drying bed site is currently maintained as an emergency back-up for sludge storage, as outlined in the City's Master Plan.

A unique feature of the drying beds is the abundance of birds and wildlife that have been drawn to the area over the years. The nutrient-filled water teems with life which attracts a variety of animals. The drying beds have been used for over 30 years as a feeding and nesting area for local birds and other wildlife. Due to the availability of water and the remoteness of the site, the area is also a resting stop for migratory birds on the Central Flyway of the United States.

Energy Recovery / Recycling

Village Creek WRF is dedicated to using its resources efficiently, and that includes recycling energy as well as biosolids recycling. Biogas, which contains approximately 40% methane gas, is produced as a byproduct during anaerobic digestion. In order to maximize electricity production, a pipeline was constructed to bring additional bio gas (approximately 30% methane gas) to the turbines from a nearby landfill. Both sources of bio gas are combined and used to generate electricity on site.

Approximately 60% to 65% of current plant energy requirements are produced by this on-site generated power.

Bio-gas Turbine

The City contracts with a private contractor to operate biogas fueled turbine engines used to generate electricity for use throughout the plant and steam production to drive the steam blowers that provide compressed air to the aeration basins. The engines can be run on digester gas, natural gas, landfill gas, or diesel fuel.

It is hoped future agreements will be in place with the local electrical grid owner that will allow excess on-site generated electricity to be exported to the grid. When this occurs, Village Creek WRF will be capable of utilizing both gas turbines at the same time which would allow the plant to generate 100% of the plants electricity requirement and become a net exporter of electricity.

Heat Recovery Steam Generator & Duct Burner

Heat Recovery Steam Generator & Duct Burner

In June 2012, the construction of a heat recovery steam generator (HRSG) was completed. The HRSG, recovers heat from exhaust of the gas turbines and a supplementary biogas fueled duct burner to produce steam. The steam is then used to drive the steam blowers previously discussed.

Scum Removal

All floating materials from the various treatment processes are moved to the scum holding tanks; then hauled off for landfill disposal.

Process Control

The plant's processes are controlled through the plant process computer system, manually through control stations in the control room or manually in the field. Flows are split between the different process units, and some equipment is started or stopped remotely as needed based on conditions occurring in the treatment processes and the results of lab data. Multiple computers are networked to provide for distributed controls (DCS) and operator interface. Process controls are available to off-site offices via the Water Department computer network, which connects all portions of the Water Department to one another.

The central control system acts as a focal point of plant operations. CRT displays provide windows into the plant process, offering operators opportunities to compensate for changes in plant processing and select control strategies while computers are left with the mundane tasks of making continual adjustments for control. The process computer also provides for equipment monitoring, alarming, data-logging, database and statistical reporting.

Village Creek WRF Support Sections

Laboratory

Laboratory Sampling and Analysis

The Water Department's Laboratory Services Division analyzes wastewater and sludge samples collected throughout the day from all treatment phases. Staff chemists and microbiologists use automation to help analyze wastewater samples. Results are used for process control, monitoring treatment effectiveness and reports to regulatory agencies.

Analyses include metals and priority pollutants in the influent, effluent and sludge, microbial counts, oil and grease, organics and inorganics, dissolved oxygen and suspended solids in the aeration basis, and anaerobic digester activities for methane gas production.

Pretreatment Services

Pretreatment Sampling

The City of Fort Worth's wastewater treatment program begins with the Pretreatment Services Division. Pretreatment Services is responsible for monitoring and controlling wastewater pollution from commercial and industrial sources as authorized by a city industrial waste ordinance.

Wastewater enters the Village Creek WRF from the City of Fort Worth and 23 wholesale customer cities. Pretreatment Services monitors this wastewater for toxic substances that could create a hazard in the sewage system and/or inhibit or damage the plant's biological treatment processes.

Specifically, Pretreatment staff work with non-compliant industries and wholesale customer cities within the framework of an enforcement response plan to reduce toxic substances discharged to the Village Creek WRF. Semi-annually, all significant industrial users submit reports outlining their compliance status with ordinance and permit conditions of the pretreatment program.

All industrial users within the area served by Village Creek WRF are periodically surveyed. Significant industrial users are identified and issued wastewater discharge permits that limit substances that enter the sewer system. These industries are monitored and inspected both on a routine and random schedule.

Wholesale Customer Metering

Metering Station and Equipment

All 24 communities served by Village Creek WRF are flow metered with remote polling into computer databases. Over 85% of all wastewater from these communities is metered.

Rain gauges have been installed at 27 of the metering location to determine how wastewater flow rates are affected by rainfall. The City of Fort Worth Wet Weather Management Program Offices uses Telog software and databases for sewer modeling.

Staff members have portable flow meters and other instrumentation to determine accuracy and reliability for future capital outlay request.

Reclaimed Water

Village Creek Reclaimed Water Pump Station

Type I Reclaimed Water: Effluent from the deep media filters is sent to the ultraviolet (UV) disinfection system which utilizes two banks of UV modules treating a total of 6 million gallons per day (MGD). If additional volume is needed or the UV system is unavailable, then the reclaimed water goes to the pump station which consists of three 200 hp vertical turbine pumps each with a design capacity of 4 MGD. All three pumps operating at full capacity can provide a total of 12 MGD to the distribution system. Operational pressures are typically in the range of 55-90 pounds per square inch (psi). A booster station helps provide residual chlorine for the reclaimed water distribution system, which in turn supplies reuse water to three wholesale customers (City of Arlington, City of Euless, DFW Airport) as well as retail customers within the City of Fort Worth.

Type II Reclaimed Water is currently provided to the Waterchase Golf Course. In the future, this service will be converted to Type I Reclaimed Water.